Cowl and Leal,

A BRIEF RESUMÉ

of the

CLINICAL EXAMINATION

OF URINE

CHEMICAL AND MICROSCOPICAL,

BY

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Compliments of
Drs Leal & Cowl.

Prologue.

Altho the institution, by the Faculty of the College, of a course of Laboratory Work in Urinary Analysis, both Chemical and Microscopical, has been of marked benefit to the class for which it was designed, as well as to those students, further advanced, who were able to avail themselves of it, others, comprising the majority of the senior and middle classes, were unable to take advantage of these facilities, and have at times expressed their regret at such inability.

Drs. Cowl and Leal have, therefore, prepared a summary of this instruction, including more or less of its clinical application in practice, sufficient for all the needs of the ordinary "Clinical Examination of Urine." Copies of this matter, have been prepared, and altho not completed in time for general inspection, they are now submitted to those, who may not wish to take up the extensive study of the urine, as provided for in the various text-books upon the subject, and yet who desire to be familiar with the methods of ordinary urinary analysis and the import of the facts to be observed.

March 15th 1883.

The Authors

Copies may be obtained of the Janitor of the College, Mr. Frank Dyer.

Contents.

Apparatus.

In the chemical examination of urine for clinical purposes, but very little apparatus and few reagents are absolutely required. Many of the regular pieces may be satisfactorily replaced by domestic articles of every day use and small cost.

The necessary apparatus consists of:-

a) Test tubes.
b) Pipette, plain.
c) Urinometer and cylinder.
d) Alcohol lamp or Bunsen burner.

In addition, it is desirable to have:-

e) Rack for test tubes.
f) Graduated Pipette (Mohr's)
g) Conical Test glasses (3-4 ounces)
h) Porcelain evaporating dish.
i) Watch glass.
j) Copper water bath and stand.

If the more exact methods of examination are resorted to, other and more complicated apparatus will be needed, descriptions of which may be found in the text-books.

Choosing and Using Apparatus.

Test tubes should be chosen that are of even thickness and free from the button of thickened glass so often found at the bottom.

The thinner the tubes the less likely to break on heating. Test tubes may even be replaced, (in most of the tests,) by ordinary two dram homeopathic vials. From four to six tubes will be needed; a good selection is, two of each, of 4, 5, and 6 inches in length. In heating a liquid in a test tube the flame should not come in contact with the dry part of the tube, nor should the tube be allowed to remain

quiet in the flame, for by so doing it becomes unevenly heated and is liable to crack; it should therefore be constantly shifted about in the flame, either by an up and down motion or by turning. If the tube is more than half full the flame should be directed upon the upper part of the column of fluid, while the tube is constantly turned, being held at the bottom. This constitutes the "boiling at the top" as directed in some of the texts. Test tube holders are unnecessary, as by proper manipulation the fingers can be safely used, or a folded strip of paper passed around the neck of the tube, the ends being held by the fingers, will be a sufficient protection.

The test tube rack is not absolutely necessary. By cutting some round holes in the cover of a box 2-3 inches high, a rack can be simply made. The regular racks should be supplied with pegs upon which the tubes may be reversed when not in use. Test tubes, as well as all apparatus, should be cleansed immediately after use, before the solid matters have had a chance to dry upon them. Ordinary pipettes, such as that required in Heller's nitric acid test, or for the collection of sediment for microscopic examination, can be easily made from a piece of German glass tubing 15 inches in length and 3/16 to 1/4 inch in diameter, by heating it at its middle <u>while turning constantly in the flame</u>, until the glass softens, when, by removing from the heat and using traction, the tube can be drawn out a trifle. Then, by first making a scratch with a file midway of the contracted portion, the tube may be easily broken in two. Now by holding the ends of the tubes in the flame until softened just enough to obliterate the roughness, two pipettes are formed that will answer all purposes except of measurement. Should a pipette for this purpose be desired, the best to procure, is one of Mohr's holding 10 cubic centimetres (2 2/3 fluid drams)

and graduated to fifths of a centimeter. (3.2 minims)

The Urinometer should be graduated in degrees from 1000 to 1060 and accompanied by a glass cylinder to hold fluid to be tested for specific gravity.

Urinometers should always be compared when bought with some instrument of known accuracy, by placing them successively in distilled water and solutions of salt and water of various strengths.

The urinometer with the longer scale and greatest distances between the degree marks, is usually more accurate. Urinometers should be rinsed with water immediately after use and then dried without wiping as they are easily broken. An alcohol lamp, (a Bunsen burner may be substituted if gas is accessible) should be of one or two ounces capacity, and the wick tube should be free to respond to any pressure from the inside, to prevent accident. When an alcohol lamp is not at hand, test tubes can be heated over the chimney of an ordinary lamp, holding the tube high enough not to cause smoking.

The conical test glasses should have sufficiently rounded bottoms to admit the finger, in order to cleanse them. The tops should be ground and they should be supplied with ground glass covers. Two will be sufficient. They may be replaced by ordinary wine glasses of proper shape.

The porcelain evaporating dish is best of the Royal Berlin porcelain, and should be 3½-4 inches in diameter and "shallow."

The copper water bath needs no description. It is to be bought. It may be replaced by an ordinary tin tea pot, although this is quite inconvenient on account of the discoloration of the evaporating dish by the iron.

Reagents.

Reagents should be kept in white glass bottles, preferably of moderate size. (4 ounces capacity for instance.) The bottles should be supplied with well ground glass stoppers, except those containing strong alkalies, which may be stopped with rubber corks, or if the glass stoppers are used, they should be coated with paraffin or beeswax: otherwise the solutions attack the glass and cement the stoppers tightly in place. If desired to protect the reagents from light, the bottles may be covered with black paper; but the better way is to keep them in a dark place, when not in use, for if the bottle be covered, the condition of its contents cannot be seen.

Glass caps are supplied, that slip loosely over the top of the bottles, thereby keeping out the dust and preventing contamination. Reagents should always be poured from the side of the bottle opposite the label.

The stopper should never be laid against things metallic nor upon a dirty surface. When reagents are drawn from the bottles by means of a pipette, (which ought only to be done in rare instances) great care must be used to prevent the introduction of foreign matters.

The necessary reagents are:-

1. Nitric Acid.- HNO_3 - Chem. Pure.

It is best kept in the dark as under the influence of light and air, it partially decomposes after a time, yielding the oxide of nitrogen - NO_2 - which imparts the yellow color so often seen.

Should the acid thus change it need not be thrown away, but may be mixed with the contents of the bottle of nitroso-nitric acid.

2. Nitroso-nitric Acid - $HNO_3 + NO_2$
or fuming nitric acid - so called nitrous acid of the shops. (Used in the detection of bile pigment.)
3. Liquor Potassæ (U.S.P.)
A solution of caustic potash, (KOH) one part in water 16 parts. - Spec. Grav. 1065.
4. Stronger Potash Solution. KOH or caustic potash, in sticks, one part, water two parts (for detection of pus.)
5. Magnesian Mixture.
Magnesian sulphate (Epsom Salt - $MgSO_4$) one part, Ammonium chloride (Sal Ammoniac NH_4Cl.) one part Water (H_2O) eight parts, to which is added one part of Stronger Water of Ammonia (Aq. Ammon. Fort. NH_4OH)
6. Argentum (Silver) Nitrate Solution. $AgNO_3$.
One part of crystals to eight of water.
7. Cupric Sulphate Solution.
One part of Sulphate of Copper (Blue Vitriol, $CuSO_4$) to forty of water.
8. Turpentine Mixture (Robinson's Reagent)
One part by measure of turpentine (the older the better) Alcohol ten parts by measure.
9. Tinct. Guaiacum, of less than a year old.

In addition, should it be desired to follow out further the analysis of a specimen of urine, other reagents will be required; but as their consideration is beyond the scope of a summary such as the present, existing text-books may be referred to for their nature and use.

The Chemical Examination.

Whenever possible, the urine should be measured, and a specimen taken from the mixed urine of twenty-four hours, if that first passed have not begun to decompose: Otherwise the statement of the patient, as specific as obtainable, may be taken, as to the amount, (Tin preserve cans, which may be gauged by comparison with a pint measure, are convenient for such estimation) and a specimen chosen, preferably from the morning's urine; bearing in mind that when consecutive daily examinations are made for purposes of prognosis, specimens should be taken from urine passed at the same time each day, and this with especial reference to the interval since the previous meal.

From four to eight ounces of urine (120-240 cubic ~~inches~~ centimeters) are needed for a thorough examination. A more or less satisfactory examination may sometimes be made of half an ounce of urine.

Having received the specimen which should be in a thoroughly cleansed bottle of colorless glass, proceed to observe it with reference to the following features.

The Appearance.

a) As to sediment, for which see next chapter. b) as to color.

If light in color: with increased quantity and specific gravity, (above 1028) look for glucose; with markedly increased quantity and low specific gravity, (1010 and under) a probably simple watery excess; (hydruria, diuresis, polyuria;) otherwise with low specific gravity, albumen may be expected.

If high colored; with small quantity and increased specific gravity, the urine is apt to be that of fever: the solid constituents are here increased, with the exception, sometimes, of the Chlorides. Such an appearing urine, occurs in acute Bright's

disease, and contains albumen and hæmoglobine. Dark color may also be due to bile, as well as to blood or to excess of normal coloring matter. The recent administration of rhubarb, senna, santonin, gallic acid, iron and gallic acid, and carbolic acid, likewise causes a more or less heightened color of the urine. Pigment in the latter instances is apt to be deposited. In liver disease, a dark color is often observed whether biliary matter be present or not.

<u>The Reaction</u> of the urine is normally slightly acid. It may, however, from transient causes, be neutral or slightly alkaline.

The reaction is determined by the use of test papers: those usually prepared being colored with red or blue litmus, (a vegetable coloring matter) the latter turning to red when placed in an acid solution, and the former to blue when in contact with an alkaline fluid.

Before pursuing the chemical examination further, a portion of the specimen should be set aside, as directed in the Chapter on the Microscopic Examination.

<u>The Specific Gravity</u> of urine is normally 1020 or thereabouts. It may vary considerably. In health, a decrease is invariably accompanied by an increase in the quantity and <u>vice versa</u>. If not clear the urine should be rendered so by filtration, or if the turbidity is due to a soluble sediment (as of urates) by dilution with an equal quantity of water (preferably distilled water) bearing in mind in the calculation, that the specific gravity of the mixture must be increased by doubling the last two figures, in order to obtain the true specific gravity of the specimen. The temperature of the sample should be brought to that degree marked on the urinometer (usually 60°) and the glass cylinder

having been partially filled with the urine (poured down its side to prevent frothing) the urinometer is introduced and allowed to sink slowly until it comes to rest, when the degree should be noted: the urinometer is now depressed in the urine and allowed to become quiet again; then looking through the upper part of the column of fluid, as nearly on a level with its under surface as possible, note the distance between this level and the next mark on the scale below it, when the exact degree will be apparent. The specific gravity should always be taken, as it will often serve, in connection with a knowledge of the daily quantity and color, to give valuable indications.

High specific gravity (1030 and over) is most frequently due to diabetes, (mellitus.) Moderately increased specific gravity (1025-1035) may be found also in fever and other disturbances of the blood and of general nutrition, in acute Bright's disease, and the exacerbations of chronic nephritis, in renal congestion, and in conditions of diaphoresis, normal or pathological. Healthy urine in summer may reach 1032.

Low specific gravity (1010 and under) is apt to be the result of chronic Bright's disease, if the quantity be not greatly increased; at times in hysteria and like neuroses.

It is usual to proceed with the tests for albumen and glucose after determining the specific gravity, for the reason, that these substances, when present, influence the subsequent tests; and if discovered, it is seldom necessary to carry the chemical examination further.

Albumen: A reliable test for albumen in the urine is Heller's nitric acid test. The urine should be filtered, if not perfectly clear. Place then a convenient quantity (e.g. 10 minims) of pure nitric acid in a test tube, and having

inclined the tube to an angle of 30° with the horizon, its wet side uppermost, allow the urine delivered slowly from a pipette, (as by rolling it between thumb and middle finger with the index on top,) to flow down the side of the tube and overlie the acid. If albumen is present a more or less opaque layer forms at the point of union of the two layers of fluid.

Should a rather granular whitish layer appear ¼ to ½ inch above this point, well defined below, but merging gradually into the urine above, it is due to the formation of acid urates, and is soluble in water; therefore, if doubt be felt as to the cause of the opacity, the urine should be diluted with an equal volume of water, and the test repeated.

If a ring of coloring matter forms at the junction of the urine and acid, so dark as to render the test obscure, the urine must either be diluted with water, (which, it must be remembered may so reduce the amount of albumen as to render it undiscoverable,) or filter through a layer of animal charcoal placed on the filter paper in the funnel.

The presence of albumen in urine, provokes a strong suspicion of Bright's disease, to be confirmed only by the microscopic examination or a positive group of symptoms.

Albuminuria may also be due to simple renal congestion, to fever and other blood changes, to parasites in the Kidney, to the discharge of pus and of blood, and to causes undeterminable.

The amount of albumen in the worst cases of these seldom exceeds two per cent. that is, the weight or even the bulk of the desiccated coagulum, is seldom more than two parts in a hundred of urine. This is true of many urines which become solid upon being heated.

<u>Glucose</u>; or Grape Sugar. ($C_6 H_{12} O_6$) If albumen is present in a urine to be tested for glucose, it must be coagulated by

boiling, (after adding a few drops of acetic acid) and separated from the urine by allowing it to settle and then decanting the clear portion.

Small quantities of albumen, however, may be ordinarily disregarded. To detect glucose, place in a test tube sufficient water (distilled or rain water) to fill the tube two-thirds full; add enough copper sulphate solution to impart a blue tinge to the water, and twice as many drops of liquor potassæ, then add ten to twenty drops of the urine; mix all thoroughly and boil at the top. If glucose is present, a yellow precipitate appears, which is often so slight that only a yellow color is imparted to the urine, yet forming, nevertheless, a distinct and decided change, and making the test a delicate and accurate one. Undiluted urine, from the presence of mucus, more particularly, will at times react to the test, when no sugar is present. Should a dark (almost black) precipitate form it is because of an excess of the copper salt, and more potash solution must be added, and the test repeated.

The presence of glucose in urine is diagnostic of Diabetes (Mellitus). It usually occurs in large amount. For daily clinical comparisons of diabetic urine, the quantitative method easiest of application, is that of Dr. Roberts. The urine is divided into two portions, one of which is placed in a freshly cleansed bottle and tightly corked. This should be entirely filled with the urine. A bottle about three times the capacity of the first, is partly filled with the other portion of urine, and loosely stopped with a nicked or perforated cork, after the addition of a small quantity of yeast. Both bottles are now put in a moderately warm place, until fermentation has ceased in the larger bottle (usually 24 hours). The specific gravity of both specimens is then taken and the number of degrees lost by the fermented urine is equal to the number of grains of glucose in one fluid ounce of the original urine, premising that spontaneous fermentation has

not to any degree gone on in the urine of the smaller bottle. To avoid this, specimens at the start should be quite fresh, and come into no contact with the spores of the yeast, by means of fingers, urinometer, glasses, etc. before bottling.

Organic Solids:- A chemical examination with reference to the estimation of the various organic matters of the urine, is seldom of clinical use, except as to urea.

Urea: In the present state of our knowledge, there is, as a rule, no clinical need for more than an approximate estimation of urea in urine. This may be made by noting the specific gravity, the quantity, and the apparent amount of the other more important solid matters.

Thus, if the quantity is 1500 cubic centimeters (50 ounces) the specific gravity 1020-1024, albumen and glucose absent, and the chlorides and phosphates normal, it may be presumed that the urea is normal in amount: (2-2½ per cent) Under the same conditions, a lower specific gravity would correspondingly indicate a decrease in the urea. If the quantity be less than normal, and the specific gravity low, the amount of urea is necessarily still smaller.

On the other hand, if the quantity be lessened and the specific gravity normal or heightened, the relative amount of urea may be inferred from the specific gravity of the urine after dilution to the normal amount. For instance, if there be one-third less urine in 24 hours than normal, to a portion of the 'mixed urine', add half as much water (preferably distilled) and take the specific gravity of the mixture.

The quantity of urea excreted daily, fluctuates principally in accordance with the amount of nitrogenous food taken, such as meat and portions of the cereals and legu-

minaceous vegetables. (peas, beans and lentils). It is however markedly diminished in various diseases. Notable increase, likewise, is ordinarily the result of morbid processes. It is always increased in diabetes. (mellitus.) and in proportion to the amount of glucose (about in a ratio of 1 to 2.2). Excessive physical exertion, particularly if prolonged, greatly increases it. Augmented ingestion of water, causes the kidneys to eliminate larger amounts of urea. The skin normally, and the stomach and intestines (by diarrhoea) pathologically, help to rid the organism of the excretion.

Table and other salts, probably by increasing the action of the Kidney, induce a greater elimination of urea through the urine. Urea is increased in amount in febrile conditions generally, with the exception of acute Bright's disease and the exacerbations of chronic nephritis. Marked and continuous excess of urea, not attributable to any discernable cause, may occur, and cause a general asthenia with emaciation.

Difficult excretion of urea, is most frequently due to acute or chronic Bright's disease, and is in reality the most vital and alarming factor of these conditions. Owing, however, to the number of causes which may affect the amount of urea, excreted by the Kidney, and especially the more or less compensatory elimination by the skin, and also, perhaps, because of the lack of extensive investigation in the matter, the estimation of the amount of urea excreted, is not as valuable clinically as it would appear to be. This is more especially true of the exact ascertainment of the daily amounts by quantitative analysis, which is, moreover, somewhat difficult, delicate, and tedious of application. The rough estimation of the amount of urea, however, is not to be neglected, as it indicates, more or less truly, the amount of functional work done by the Kidney, and often indicates

the greater or lesser amount of disease in these organs. The lessened elimination of urea by diseased Kidneys, is physiologically far more important than the loss of albumen.

Diminution of urea may be due to other causes than Bright's disease or renal congestion, as cholera, acute yellow atrophy of the liver, and rest in bed with low diet.

Inorganic Solids:- The amount of normal solid matters of inorganic composition, (i.e. possessed of no carbon) may, for all ordinary purposes, be estimated by approximative methods.

The Chlorides:- The chlorides (principally chloride of sodium,) are thrown down as silver chloride (Ag Cl.) on adding first ~~first~~ a few drops of nitric acid to about two drams (7½ c.c.) of urine in a test tube, and then a drop of a solution of nitrate of silver. (1-8) If the chlorides are normal or increased in amount, (and an increase is seldom if ever, of any importance,) the precipitate forms as a curdy mass in an otherwise clear solution, and falls to the bottom in clumps. If the chlorides are diminished, the precipitate is much less in amount and more diffuse, so that if the amount of chlorine in combination is very slight, the precipitate causes only a general cloudiness diffused through the solution. The chlorides are diminished or absent during the exudative stage of many inflammatory diseases and notably pneumonia. They reappear or approach their normal amount at the beginning of resolution.

Earthy Phosphates: To estimate the amount of earthy phosphates (of lime, and of magnesia and ammonia) present in the urine, a six inch test tube is filled one-third full with the clear

urine, a few (e.g. five) drops of potash solution added, and the mixture heated until the flaky precipitate of the earthy phosphates separates. The tube is then allowed to rest for ten minutes to allow the precipitate to settle, when, if the earthy phosphates are normal in amount, there will be a depth of sediment of about one-third of an inch. The precipitate may be white (normal) or darkened by the coloring matters present the specimen, such as uroerythrine, blood, bile, etc.

The earthy phosphates are increased in osteomalacia (mollities ossium) and rickets.

The Alkaline Phosphates: (of sodium and potassium)

These form the greater part of the phosphatic salts in the urine. They are thrown down in connection with the earthy phosphates, upon the addition to any quantity of urine, of one third as much of the "magnesian mixture." The precipitate is white and granular, giving a milk-like appearance to the urine when in normal amount. The alkaline phosphates vary principally according to the character and amount of the food. They are increased in conditions of excessive mental action, in acute inflamation of the nerve centres, and also after severe mental exercise. (likewise a cause of nerve waste)

They are apt to be diminished in Brights disease, and all chronic affections of the nervous system, including insanity (except in acute mania)

The Sulphates: (of potassium and sodium)

These salts are of barely any clinical importance. An exception, may be the fact, that, in contradistinction to other fevers, acute rheumatism causes an increase in their amount.

They are thrown down as a scanty granular white precipitate by a solution of chloride of barium.

Coloring Matters: Of the normal coloring matters, 18
Indican is the one more likely to be of clinical import; but as knowledge concerning it, is yet in an unsettled state, its consideration is without the scope of the ordinary clinical examination of specimens of urine.

Uroerythrine: Another coloring matter, abnormal at least when present in marked amount, is uroerythrine. It can be recognized after the exclusion of other coloring matter, by the tint it imparts to the sediment, if any be present, or to the artificial sediment produced in testing for earthy phosphates.

Hemoglobine: The coloring matter of the blood, which, except in the urine of females during menstruation, is an abnormal constituent, may be recognized by adding to about a dram (3¾ c.c) of the urine, in a test tube, one drop of tincture of guaiacum, and then about half a dram of the "turpentine mixture". If hæmoglobine is present the solution immediately assumes a blue color varying in shade, by blending with the yellow or red of the urine, and in intensity according to the amount of blood coloring matter present. It should be borne in mind that there may be hæmoglobine when no blood discs (red cells or corpuscles) are to be found on microscopic examination. Should the color fail to appear in performing this test, within thirty seconds, it may be positively said, that no hæmoglobine is present in the urine. Urine containing hæmoglobine is albuminous, whether corpuscles are present or not. Blood coloring matter occurs in the urine of acute Bright's disease and the exacerbations of chronic nephritis. Hæmoglobinuria as contrasted with true hematuria (urine containing blood discs) occurs as an intermittent affection, and frequently also as a symptom in the course of continued fevers, in purpura and in scorbutics.

Biliary Coloring Matters: impart to the urine more or less of an olive hue and the froth produced by ~~the~~ shaking the specimen is of a distinct and usually of a decided yellow color. The best test for the bile pigments is a modification of Gmelin's.

Fifteen or twenty drops of the urine are placed on an ordinary white-ware dish, and on another part of the plate, about the same quantity of the nitroso-nitric acid. The urine and acid are allowed to come together, and at the line of contact will be seen a play of colors, in which green, (which must be present) usually predominates, if the specimen contain biliary coloring matter.

Sediments. It is occasionally desirable to examine a urinary deposit chemically; this may, except where rare matters form the sediment, be simply done. We can easily exclude however the more common deposits.

Urates: The most common deposit in urine is composed of urates, which may be dissolved by adding water or by heating the specimen. They are usually colored by uroerythrine and vary in color from a pinkish tinge to a decided red. Blood and bile pigments also impart their color to this sediment.

Pus: Pus cells in mass appear as a granular, diffluent and light rather than heavy sediment. If the urine be markedly alkaline they will be collected in viscid masses, which do not disappear on heating, nor on the addition of acid: but upon the addition of an alkali, become transparent and ropy. Therefore, to test for pus, transfer a portion of the sediment, by means of a pipette, to a watch glass, and add an equal bulk of the stronger solution of caustic potash, when, if the sediment is purulent, it will become like the white of an egg in consist-

tence and color, and when poured from the glass, will stretch out in strings of considerable length. It is probable that the various forms of epithelia (particularly young cells) would give the same reaction, but it is seldom, if ever, that they are ~~formed~~ found alone in sufficient numbers.

Uric Acid: Uric or Lithic acid occurs as a sediment and is tinctured by the coloring matters present in the specimen. It may be ~~detected~~ detected chemically by the so called murexide test. A portion of the sediment is placed in a watch glass or evaporating dish and a few drops of nitric acid added. The whole is then heated carefully over a sand or water bath until the acid is driven off.

Upon the addition of sufficient potash solution to moisten the residue, a purple color will appear, if uric acid be present.

Lastly, in all operations upon urine, it is important to acquire the habit of using the same quantities of solutions in every repetition of a test, for by so doing, comparison becomes easier, and more accurate methods are acquired.

The Deposition of Normal Urinary Sediments.

Normal urine upon standing at rest for a few hours, deposits a slight sediment of mucus and cast off epithelial cells, which is to be observed as a slight cloud floating near the bottom of the vessel, or it may be near the top. This sediment is flocculent and diffused, rather than compact, and is not appreciably viscid. After a time, the urine becomes of a more acid reaction, and deposits a slight sediment of pinkish granular urates of soda, ammonia, and lime, which are dissipated on heating the specimen. Under the microscope these urates are of a yellow color. If the urine clear when passed, becomes cloudy as soon as cool, it is from a similar deposit which in this instance may be considered pathological.

Later on, as the acid reaction of the urine increases small crystals (often called "sand") red in color, of uric acid, are deposited upon the sides and bottom of the vessel to which they are more or less adherent. Under the microscope, these crystals are of various shapes and yellow in color. They are not infrequently accompanied by microscopic crystals of oxalate of lime, which possess in general an octahedral form and a transparency that gives them the appearance of perfectly square bodies with bright diagonals. These form a central cross much like that on the back of a square envelope, the limbs being wider towards the centre than at the ends.

The crystals of uric acid, if found in large numbers or immediately after urination, are considered pathological. The same may be said of the oxalate. The conditions are sometimes dignified with the names of Oxaluria and Lithiasis. The latter name however should be restricted to those cases where small calculi are actually excreted with the urine. ("gravel.")

A large excess of uric acid and urates, attends an attack of gout; otherwise an abnormal deposit of uric acid, urates or oxalate of lime, indicates nothing more than incomplete blood-metamorphosis, which may occur in a variety of conditions. If a specimen of urine be alkaline instead of acid, when ~~evaporated~~ evacuated it will be opaque because of a white deposit of amorphous phosphates. If the odor be offensive, the specimen is pathological and generally indicates cystitis; if, on the other hand, it be inoffensive or odorless, the urine is normal. It has simply deposited part of its phosphates, because of the lack of acid wherewith these salts are normally preserved in solution. The same phenomenon of phosphatic deposition may occur in urine of neutral reaction. This sediment entirely disappears in normal urine on agitation with a small amount of acid. In such normal urines depositing phosphates, the specimen from being neutral or alkaline, becomes, nevertheless, after a time, of an acid reaction, and still later on, as in all urine, of a decided alkaline reaction, with offensive odor. The phosphatic sediment in the change to an acid reaction is not however dissolved, while the urates and uric acid, thrown down as a result of the change, are in fact deposited upon it.

The acidity of the urine gradually decreases until it is neutral. Then occurs a fermentation (a putrefactive decomposition) of the organic matters in solution. The uric acid is decomposed into urea, oxaluric acid, carbon dioxide, and water. All the urea is further and finally decomposed into Carbonate of Ammonia and Water. $CO(NH_2)_2 + 2H_2O = (NH_4)_2CO_3$ This fermentation is caused and effected by bacteria, fungi, germs of decomposition, derived from the atmosphere. If these germs, which are possessed of a general diffusion in nature, should not, however, find entrance to the urine as is sometimes the case, where a recently cleansed bottle is filled with fresh normal urine,

containing little mucus, and is corked tightly, the specimen may stand for weeks or even months without undergoing the alkaline fermentation.

If but a few spores or germs of these germs be present, fermentation will not take place unless the urine stand in a warm place.

Upon the change from an acid to an alkaline reaction, during fermentation of the urine, the phosphates are deposited as a white sediment composed of amorphous granules and white or colorless crystals of various sizes, and usually of one or two general shapes: viz,- of a more or less square or oblong form with the corners cut off, and of a stiletto shape, often clustered together like the sticks of a fan. The crystals of uric acid and of urates, particularly the large ones, are not all dissolved by the alkali, more especially if the urine be undisturbed.

The bacteria appear, with ordinary powers, as still or trembling, single or coupled dots, as larger or smaller granular masses, (zoogloea) in which the dots may be either quiet or vibrating, and again as beaded lines, which may or may not possess the vibratile motion. Vibrios are a special kind of vibrating bacteria, but are not to be distinguished with ease ordinarily. Bacteria in urine are exceedingly minute, being by far the smallest microscopic objects found therein. They are colorless and do not appreciably absorb eosin. The presence of bacteria is always to be inferred, if the specimen possess the common offensive odor of stale urine. Bacteria may be present in small amount, however, without bad odor, as at the beginning of the alkaline fermentation. The general cloudiness of ammoniacal urine, that is not to be removed by ordinary filtration nor the addition of nitric acid, which dissolves the deposited phosphates, is due to bacteria. The addition of one tenth part of a one per cent. solution of carbolic acid will, in general, cause the movements and propagation

of the bacteria to cease, yet without destroying their vitality. Their tenacity of life is great. Upon the evaporation of the carbolic acid, however, decomposition will be resumed and completed. At this last point the bacteria cease to move and to propagate, because of the exhaustion of the pabulum upon which they have fed, namely, the organic putrefactive or fermentative matters of the urine, urea, uric acid, mucus, etc. They do not die however, but break up into minute spores, which possess a much greater power of withstanding vicissitudes of temperature and humidity than the parent bacteria. Bacteria are apt to be found congregated in and about organic solids in decomposing urine such as casts, epithelial cells etc. which they doubtless consume. They may thus prevent the recognition of important objects. Fungi also consume and remove albumen and sugar from urine.

Other other infusorial fungi than bacteria, occur in urine, but only when acid or neutral. The sugar fungus or yeast plant which appears sooner or later in all diabetic urines and sometimes in others, is characterized by one or more oval or circular, colorless, non-granular, spores, frequently forming in a row or small cluster, sometimes with a branching column. They are of varying size, but many times larger than a bacterium. At times they possess a vibratile motion similar to that of the bacteria. Like the latter, also, they are not colored by eosin.

Another fungus, at times appearing more or less like the torula cerevisiæ or sugar fungus, is the penicillium glaucum. It also occurs in acid urine, and especially in that which is albuminous. It may occur alongside the sugar fungus in diabetic urine. It presents itself in long narrow rods, which often form an irregular net-work. Oval spores may be discerned at the ends of the mycelial rods.

If the alkaline fermentation have taken place within the body, the urine is pathalogical, and is usually coincident with suppurative inflammation, generally of the bladder. The pus in this case, is more or less changed by the alkali into extremely viscid yellowish matter, known as muco-pus, and often incorrectly called viscid mucus. Under the microscope, not all the cells are destroyed however, but as a rule, few will absorb coloring matter, showing that decomposition has begun. The same may be said of other cells which do not absorb the dye. In urine, yet undecomposed, cells and especially young cells, will be deeply stained. The nuclei of all cells are most markedly colored.

To recapitulate; as already indicated, a deposit, generally pinkish, appearing as the urine cools, to be dissapated by heat, and composed of fine yellowish or even darker amorphous granules, often accompanied by deep yellow or dark spherical crystals some of which may possess projecting spikes, is composed of urates. A deposit like red sand, composed of colored crystals of various shapes under the microscope dissolving upon the addition of alkali, is uric acid. The urates and uric acid are natural to acid urine.

A white deposit only found in alkaline or neutral urine, soluble in acid, is composed of phosphates, and is without color under the microscope.

A diffluent sediment soluble neither by heat, by acids, by alkalies, nor in ether, is organized and is composed of pus cells, casts, epithelial blood or other cells, or bacteria. All matters except free fat, blood cells, bacteria and other fungi, subside and leave the supernatant urine clear. To determine which, some urine must be drawn from the fluid at the top and placed in a test-tube.

Microscopic Examination.

Allow the fresh urine to stand at rest for one to two hours in a corked bottle. Draw off what sediment has collected with a pipette, after lowering it to the bottom of the bottle, (except in certain instances where the solid matters float about as a slight cloud) with the fore finger lightly placed upon the top of the tube until the other end reaches the lower strata of the deposit.

Add to this fluid withdrawn, about one tenth its bulk of a solution of Eosin (a red aniline dye) and Carbolic Acid to preserve the urine from decomposition, and to color the organic matters in order to their more easy observation and distinction. Place the mixture in a conical or conoidal glass vessel with a level top, holding from two to four ounces, and covered with a piece of ground glass upon which is written in ink the name or number of the specimen.

After a period of from one to four hours or more, to allow the sediment to subside, fill a four ounce beaker glass or common tumbler with water and place therein a pipette of about six inches in length. Provide a piece of washed unstarched linen.

Fit upon the microscope stand, to begin with, a low power objective, 2/3 or 3/4 inch. Turn the diaphragm plate so that one of the smaller openings shall be under the objective. Place the centre of the mirror directly in line with the tube of the microscope, with its flat side uppermost.

With the eye piece in its place, lower the tube carrying the objective, until the latter is about 1/4 inch from the stage, and turn the mirror on its two axes (without moving its supporting arm) until the field of light is uniformly bright. This field varies in width from 1/10 to 1/50 of an inch nearly, with the powers most suitable for urinary work and represents a magnification of from 50 to 450 diameters. The

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* Water 100 parts, Carbolic Acid 5 parts, Eosin 2 parts.

range, however, may only extend from 75 to 400 diameters without lessening the capabilities for work. All varieties of power between the limits named are to be obtained by different coupling of the lenses and the use of the draw-tube. Twist the eye-piece in its bed, to notice whether specks are seen to revolve. If so, the outside of its two lenses should be carefully wiped. The cap must be removed from the upper one, to do this. The same may be more carefully done with the objective. Entire absence of dust on the mirror, is not so important. Moisten a glass slide in the water and wipe perfectly dry, blowing from it any linen fibres remaining adherent. Repeat the same carefully with the cover-glass, grasping it by the fingers of but one hand at a time, to avoid breakage. Place each upon a cleansed surface, such as the foot of the microscope, from which they may be easily removed by grasping their opposite edges. For purposes of urinary examination, by far the best kind of slide is one like the ordinary piece of plain glass 3 in. long by 1 in. wide, but ruled at its middle portion with minute lines at hundredths and thousandths of an inch or tenths and hundredths of a millimetre (1/25 in. nearly) distances. These slides are called stage micrometers and are useful for measuring the power of lenses.

For the first examination, lower the pipette (rid of water) with the forefinger tightly over the top, to the bottom of the sediment. Allow but a small quantity of the deposit to enter the tube by momentarily releasing the forefinger from the top. Remove the pipette, drawing the lower end against the side of the conical glass. Bring it down perpendicularly upon the centre of the slide. Hold it there a moment, until, without releasing the forefinger from the top, a small drop of urine and sediment has flowed out upon the slide, sufficient to cover a small space of about 1/8 to 1/4 inch in diameter. Allow the urine remaining in the pipette to gently flow back into the conical glass, and place the tube in the beaker. Upon the drop of urine gently lower the cover glass, held by its edges between

the tips of the thumb and index finger, until one side touches the slide. Continue to lower until it falls. If upon inclining the slide, the cover glass moves, draw off and remove the excess of urine with the cloth held against the edge of the slide until the cover remains in position when vertical. Avoid or remove all over flow of urine upon the top of the cover glass. Place the slide underneath the clip or clips, upon the stage of the microscope and looking through the eye-piece, gradually raise the tube by the coarse adjustment until objects come into view. Render their appearance* distinct by turning the fine adjustment screw.

Move the slide or sliding stage (a marked advantage for this work) about under the objective, by grasping its corners with the thumb and forefinger of each hand. Center any object which it is wished to examine, (because of the greater perfection of the lenses in their central zones) and turn the fine adjustment screw to and fro, to view the object in its different planes. Avoid making an effort with the eye to see objects slightly out of focus. Let the fingers on the milled head do all the accomodation in examining objects. In rapidly glancing over a field when searching for casts etc. while continuously changing the field, it is not necessary to keep the hand on the slow motion. Immediately upon seeing an object which, on glancing at it, seems to resemble an object sought, transfer the hand to the fine adjustment. At all times keep the unused eye open.

To use a higher power objective 1/4, 1/5, 1/6, 1/8 in. etc. lower the tube until the reflection of the objective in the cover glass almost coincides with the lens, then focus as before. If the mount of the end lens of the objective be conical, however, one must view the actual space between the lens and cover glass, from the side.

If additional magnifying power is desired, pull out the tube into which the eye piece fits, to a convenient length.

* Especially the desired objects thus avoiding a study of matters on the top of the cover glass or the bottom of the slide.

In lowering the draw-tube again, the objective must first be raised away from the slide. The same precaution is to be exercised in removing the slide.

Especial care should be used to keep the objective from coming into contact with urine. For examining a second drop of urine the same slide and cover glass should be used, after being cleansed by rinsing well in the water and carefully wiping.

All tools coming into contact with urine should be immediately and thoroughly cleansed after use, especially in those parts where urine has dried upon them.

The Detection of Deposits in General.

The number of microscopic objects, normal, pathological, and extraneous, occurring in urine is large.

The distinction of some of them from others, particularly of the rarer forms, is often difficult and delicate.

A very considerable knowledge of chemistry as well as of microscopy is necessary to their uniformly sure detection: a more special knowledge than the student or practitioner in general has time or opportunity to obtain. The recognition, however, of the more common and clinically important forms of urinary deposits, is not difficult after a little experience and perhaps some teaching.

The aid also, which, in the absence of photographic representations of urinary sediments, a fair series of prints give, such, for instance, as are to be found in Da Costa's works on Medical Diagnosis, is not inconsiderable. Moreover, the individual can prepare or secure many of the objects he will meet with in urine, and examine them separately.

When, however, these means fail, a vivid remembrance of an accurate specific description of most of the objects to be

met with, will enable the observer, as a rule, to recognize them when of their typical shape.

Objects, also, on the other hand, of shapes or colors not typical, for many such occur in urine, may, at least by the beginner, be in general disregarded. Old cast off epithelial cells having lost their nucleus and become more granular, perhaps covered by crystals, which are apt to form on these as on other solid objects; crushed or amorphous crystals, frequent in a composite fluid containing organic matter like urine; bits of various extraneous matters such as dust, linen, cotton, etc. are exceedingly apt to puzzle the beginner but will soon be passed over as unimportant by the eye in searching a microscopic field. This fact however should not make the search less thorough or painstaking, for there is a very considerable liability that deposits, even important ones, may pass under the eye unnoticed. This is especially the case where the objectives are not often changed. It is fortunately seldom that a urine displays no typical forms of whatever deposits it may contain. As a rule, atypic masses are few in comparison with those which are characteristic.

The observer may therefore feel quite sure, that if he finds no typical forms, or forms manifestly like them, the objects he sees are probably unimportant, barring all cases, of course, where decomposition has progressed so far that the deposits have either become destroyed, disintegrated, or obscured by the swarming fungi. It is always likewise to be remembered, that of the various objects to be observed, a small number are important, as casts and some other organic matters, a larger number are simply noteworthy, as crystals and other inorganic matters, while many are of little or no consequence, such as various extraneous matters.

Thus there is much which is practically unimportant in urinary sediments, at least to the practising physician, and,

needs to be noted only because of the liability to confound with it that which is important. It is to be said however that a strange form of object appearing constantly or frequently in a certain urine calls for the most careful and searching examination. It is not infrequent that otherwise inexplicable symptoms may by the discovery of the nature of a particular deposit be traced to their origin, and intelligent measures for their relief therefore instituted. The search for cause, here as elsewhere, should be assiduous. With reference to a positive decision upon the nature of any particular deposit, observed under the microscope, we must never forget the very certain help which chemistry can give in the application of reagents to deposits en masse. The various chemical reactions presented by deposits are, in fact, as positive and often more positive than the shapes, colors and arrangements of sediments upon the microscopic field.

The application of reagents, unless the observer possesses unusual skill in manipulation, is much more satisfactorily made to the sediment in bulk than upon the stage of the microscope.

The addition of ether to dissolve globules believed to be fat, for instance, is much more easily and effectively done by dealing with some little quantity of sediment which, after agitation with the reagent, and standing at rest for a time, can be again examined for globules.

These will now be absent if of fat, being dissolved in the supernatant ether. This test is with difficulty and uncertainly carried out upon the microscopic slide, particularly where we also wish to use acetic acid or liquor potassa to dissolve the albuminous coating which generally covers the oil globules of animal origin.

The detection of all objects under the microscope, where color does not aid, is due to the fact that the solid matters are in-

general, considerably however than the urine; they are denser and therefore refract or bend the light which they receive. If an object be of the same density as the urine, such as mucus and some hyaline casts, it cannot be seen unless it be colored, or happen to contain epithelial cells, granular matter etc. when its outline may be traced. Bodies which thus are uncolored, homogeneous and of the same density as the urine, can be seen as a sediment neither macroscopically nor microscopically. Hyaline casts, for instance, which are important in the diagnosis of Chronic Bright's Disease (in connection with other facts) may be discovered in a urine presenting no visible sediment; the addition of a dye being needed to detect them.

In general however a urine which has stood at rest for several hours in a conical glass and which has deposited no appreciable sediment is microscopically normal. The constant floating cloud of mucus in normal urine owes its opacity to the cast off epithelial cells which it contains.

All crystalline bodies in the urine are white, whether color have been added or not, with the exception of uric acid and the urates, which upon crystallizing absorb the coloring matter of the urine and show of a yellow hue, more or less intense, according to their size, and if a dye have been added, are colored by it when formed after its addition. The use of Eosin, for instance, thus enables one to tell whether the uric acid or urates have been deposited shortly after the evacuation of the urine or later on. Epithelial, blood and pus cells are more or less deeply colored by the dye, unless the chemical changes incident to decomposition have progressed so far as to render them non-absorbent. This point is sooner reached in the pus cell than with the others, as it is a younger and softer cell, possessing a lessened physical integrity and therefore more prone to chemical change. Cells in general as well as other organic matter, such as casts,

and mucus, are to be distinguished from crystals and extraneous matters by the darker outlines of the latter which change greatly in width in focussing.

The dyeing of organic matters furnishes a ready means to the beginner of at once deciding whether he is looking at a cell or at a drop of fat or small air bubble. To decide between the latter two, previous experiment with them separately is the only guide.

The thickness of border (black) which is in general greater in air bubbles than fat globules, as the latter differ less than the former in density from the urine, is not, although so stated, a reliable guide; as the width of this border-line depends also upon the thickness of the layer of urine between the slide and cover glass a very variable quantity in practice, owing to the unequal size of the particles of urinary sediment. The thickness of border however will serve to distinguish between a hyaline cast and an elongated air bubble which may approach the former in shape and size, while generally more pointed at one or both extremities, and usually unequal in diameter, differing thus from casts which except in rare instances, are of uniform width.

Extraneous Matters.

One of the first things to be acquired in the study of urinary sediments, is the ability to detect those various matters which in different ways are apt to enter specimens and appear under the microscope.

Extraneous matters are present as a rule upon every microscopic slide.

The manipulations incident to the preparation of the slide, and more especially those of the very cleansing of the glasses,

are almost sure to introduce particles of substance from without. Care should therefore be used to protect specimens from dust and, as far as convenient, from contact with air.

Because of this necessary introduction of extraneous matter, it is preferable to employ a substance for drying the slide and cover glass, whose particles are easily recognizable under the microscope, yet which is very absorbent of moisture. Linen is pre-eminently such a substance. Small portions of its fibres are less apt to be mistaken for pathological objects than fibrillae of silk or chamois skin, while it well takes up moisture better than cotton or wool. Particles, however, of silk, wool and cotton may get into specimens from the clothing. Similarly hairs, human and other, and bits of feathers find entrance into urine. Sputum may have been introduced. Finally milk, starch, etc. may have been added, whereby to deceive the practitioner, for purposes of sympathy, exemption from service, support & maintenance, etc., etc. Such cases of malingering have at times deceived the most elect.

If linen have been used to cleanse the slide, one will soon learn to recognize its striated fibres with frayed or jagged ends and dark borders.

Hairs are to be detected by a dark streak down the middle of the fibre, by their sharp, abrupt, or fibrous ends, and by their dark borders. Cotton is known by its flatness, more, and twisted appearance. Silk, unless it be white, is generally recognized by its dyed color and also by possessing a sharper, darker border than a renal cast. This, like these other fibres, usually much longer than a cast, not infrequently more than crossing the entire microscopic field under a [illegible] objective.

Fibres of wool have a rev. wool appearance and are apt to be curled or curving like other fibres; also they are denser

than most tests. Particles from feathers, sponges, woollen knots, little points at frequent recurrent intervals. All organic fibres will absorb eosin, if they have lain in the colored specimen any length of time. Starch granules by the inexperienced microscopist, at least, had best be searched for chemically, as by boiling and applying the iodine test. The cells vary gradually in shape and size according to their source.

Milk and other forms of fat in urine (as after the use of an oiled catheter) furnish globules of considerable size upon the microscopic field and usually in amount. Chylous urine, which contains large amounts of fat and albumen, shows the fat evenly divided in a molecular form under a 1/5 inch objective. Urine from fatty kidneys may show a few globules of some size, while the larger majority are minute. Large fibrinous casts containing epithelial and pus cells may be introduced into urine ~~by~~ in sputum from cases of resolving pneumonia, and croupous (plastic, fibrinous) bronchitis extending to the bronchioles. Vomit may introduce many puzzling matters, such as muscle and other fibres, strange fungi, etc. which have at times caused the most ludicrous mistakes.

Where fluid offered is suspected of sophistication, or of being other than urine, recourse must be had to chemical as well as microscopic examination.

Last but not always least, scratches and indentations upon the slide or cover glass, sometimes filled with pigment, or striae in the substance of the glasses, may at times mislead those of some experience.

The Clinically Important Deposits.

Casts: A cast is a clot, composed of albuminoid substance, conforming in shape to the cavity in which it coagulated. The only exceptions to this rule are where mucus retains the shape of the canal into which it is poured, and where long retained discharges have become inspissated or calcareous. The coagulating substance to which casts, except those just mentioned, owe their form and the retention of that form, is believed to be fibrin or a substance analogous thereto. Renal casts, however, except some composed of blood, do not possess a network of fibrillæ, as does an ordinary clot, but are homogeneous, except for the bodies which they may contain. These may on the other hand, constitute by far the major portion of the cast.

Such for instance, is the case in many casts, which seem to be made up entirely of epithelial cells. There is doubtless, however, a cementing substance holding all together and filling the central portion. Many casts also are largely composed of granular matter and others of distinct fat globules. These are believed to be due to the fatty degeneration of the Epithelium lining the renal tubes (the parenchyma of the Kidney) which is to be found post mortem, in cases giving origin to such cast. The granules are believed to represent the epithelial cells which have become converted into granular matter (probably fatty) by degeneration during the formation of the cast or before its extrusion. They may, however be escaped droplets of fat that have been extruded from the degenerating epithelium, which in this case is not included in but left behind by the cast.

Casts are divided into Hyaline and Waxy, Pale Granular, Dark Granular, Fatty and Oil Casts, Blood Casts, and Epithelial Cast.

A hyaline cast is a homogeneous mass with faint linear

outline. When purely hyaline it contains no granules. A waxy cast differs from it in being brighter and shining, and of greater apparent solidity. The latter seldom react however to the iodine test for amyloid matter. They are not peculiar to waxy kidney, (which does respond to this test) Waxy casts are apt to be cracked or fissured and are supposed to have lain for some time in the kidney after their formation.

A pale granular cast is of a hyaline basis, peppered with small dots more or less regularly disposed. A darkly granular cast appears to be very largely or at times almost entirely made up of granules.

In fatty or oil casts, these granules are of some conside=rable size, though varying in this respect throughout the cast. Blood casts are of a marked yellow color; red corpuscles may or may not be distinguished. Epithelial casts contain the more or less spheroidal mono-nucleated epithelial cells of the renal tubules. Sometimes we can only perceive their nuclei. The cells may be sparse in a hyaline or somewhat granular matrix or may seem to entirely make up the cast. Certain casts in cases of surgical kidney may contain pus cells. These casts are large and the cells non-nucleated.

Although casts are casts because held in shape by a matrix of solidified exudate, they may be divided into Exud=ative Casts which are homogeneous or nearly so, or which may contain blood cells; Degenerative Casts, which are granular or fatty and indicate degenerative change at their source of ori=igin; and Desquamative Casts which contain ~~tubercular~~ tubular epithelium abnormally cast off. A fourth division might be made for those few casts which contain pus cells.

Practically the divisions between these three classes of casts is not sharp, for casts which are Granulo-Hyaline, Epithelio-Hyaline, and Granulo-Epithelial are not infrequent

The definition of a cast in respect of appearance is a body, of from 1/2000 in. (sometimes less) to 1/500 in. (usually about 1/700 in.) in diameter, of a length at least twice (for positive recognition and generally four to ten times its diameter, of regular outline (unless decomposing) with parallel sides, straight or at times somewhat curved contour, and when typical, with rounded ends.

Its outline in general is rather faint than broad or distinct.

With reference to the distinction of the large majority of casts from other matters, it may be said, that the darker the outline of the object the less liable is it to be a cast. Casts are frequently so indistinct as to be recognized only by the arrangement or general outline of the granular matter or cells contained within them. Comparatively few casts possess no granular matter. Some very dark casts seem to be made up entirely of granules or droplets of fat. Between these there are all grades. The granules also vary from extreme fineness as in most hyaline casts, to a considerable size, as in what are called oil-casts.

Casts when hyaline are colorless, unless dyed yellow by bile, when darkly granular they are grayish or blackish, when containing blood cells they are marked by a yellow color. They take up eosin to a variable extent, probably according to their age. Those that are recent absorb it readily. Some refuse it entirely.

Casts in decomposing urine often soon become converted into amorphous debris, which, however very generally retains for a time its power of absorbing coloring matter. When such colored ~~masses~~ appear upon the microscopic field the presence of casts may be suspected and unusual care should be taken in transferring the drop of urine or sediment to the slide for examination, to avoid crushing or disintegrating the fragile structures. This organic debris is to be differentiated from mucus by not-

appearing in striated strings, like the latter, but in more rounded masses, non-striated, and also by its greater absorption of the dye. Microscopically, it is diffluent rather than viscid, as is the debris of decomposing pus cells. It is distinguished from bacteria by its absorption of Eosin.

All forms of casts may be found in Chronic Bright's disease. Blood casts, darkly granular casts and Epithelial casts are to be found in acute nephritis, and the exacerbations of Chronic Bright's disease. The cells in casts, which in Chronic conditions are few in number, here become numerous.

Waxy casts are in general the product of Chronic Bright's disease. They may however result from acute congestion of the Kidney. Darkly granular casts generally indicate a parenchymatous nephritis with degeneration of the tubular Epithelium. Fatty cells and oil drops are found in Chronic Bright's disease

The more numerous the casts in the deposit, the more severe the condition in general. The presence of a large number of casts indicates the involvement of a large portion of the structure of the Kidneys; all portions being never effected to the same degree, while some may be healthy at death. Casts as a rule, to which there are exceptions, occur in urine which is albuminous.

Mucus:- Mucus is a constant sediment in urine. When present in abnormal amount it is perhaps most frequently found in urine which is very acid and irritative or of high specific gravity. It rarely imparts an appreciable viscidity to the sediment. It is apt to remain unseen upon the microscopic field, unless coloring matter have been added. It absorbs eosin to a slight extent and then appears in more or less tenuous striated masses of varying width and length. Mucous strings

may more than exceed in length the diameter of the field of an ordinary 1/5 inch objective.

Mucus may have the shape of casts, and probably comes from the renal tubules whose shape it retains. It may contain granular matter also, thus still further adding to the similarity.

In general however, the granules are exceedingly dark and dense and may by chemical tests be found to be composed of urates which have been deposited upon these as upon other irregular solid bodies. A urine containing an excess of uric acid is generally irritative to the mucous membrane, and this may account for the not infrequent occurrence of what are called mucous casts and casts of urates. Simple mucous casts are sometimes with difficulty differentiated from albuminoid casts, which in fact they not seldom accompany; they are, however, in general, more fragile, less regular in outline, and apt to be sharply pointed. Mucous casts may come from the seminal tubules of the testicle and contain spermatozoa in greater or less number.

<u>Epithelium</u>: Epithelial cells occurring in urine, may come from the tubules or from the pelvis of the kidney, from the ureters, from the bladder, the urethra, prostrate gland, uterus vagina, or vulva. There are thus so many sources of origin and as a fact, so much variation in size, shape, size of nucleus, etc. in the Epithelium shed from <u>any</u> <u>one</u> of <u>these</u> organs, that it is as a rule practically impossible to say positively, from a simple examination of epithelium in an ordinary specimen of urine, whether it came from the Kidney or the bladder, or from the bladder, urethra, or genital tract. All squamous (flat or pavement) epithelium, which these various parts bear, is formed upon the same plan.

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In the lowest layers (which are seldom discharged) the cells are cuboidal, above this columnar, (cylindrical, caudate, spindle-shaped) and at the surface, more or less flat or disc-like.

An exception to the rule, that the origin of epithelium cannot, in general, be ~~entirely~~ surely certified to, is the epithelium of the renal tubules. which is spheroidal and of a size much smaller than epithelium from other sources. It is not to be forgotten however that in disease, cells are being rapidly proliferated, and are quite apt to take this shape, whatever their origin. Numbers of cells known to be normal taken together, from each of the various sources, differ enough as a rule in size, shape, and in respect of their nuclei, to be differentiated. But it is very questionable whether in disease they can be told, with a sufficient degree of positiveness, from each other.

It is not to be positively asserted, for instance, whether any one or half dozen cells came from the pelvis of the kidney, the bladder, or the urethra.

Squamous epithelial cells are most frequently large, flat, irregularly polygonal in outline, and have a nucleus about one-sixth the diameter of the cell. These come mostly from the bladder and the vagina. Cells from the latter source are apt to occur in plaques, containing half a dozen to perhaps an hundred cells. Decidedly smaller round or oval cells with one, sometimes two, nuclei, which are larger in proportion to the size of the cell, are apt to have had origin in the pelvis of the kidney. This liability is increased when there are few of the larger cells. For smaller cells accompanying ~~the~~ larger ones, may also have origin in the bladder. Columnar or elongated epithelium may come from the tubes of the pyramid of the kidney, the deeper layers of the renal pelvis, of the bladder, the ureters, the vagina, etc. Many epithelial cells in a specimen indicate acute inflamation of the mu-

cus membrane at the site of their origin.

Pus:- Pus cells may come from any part of the genito-urinary tract. Their origin is not to be inferred from their microscopic appearance, except in some cases of urethritis (clap) and prostratitis where we find numerous aggregations of from half a dozen to perhaps an hundred cells, and again in certain rare cases of surgical Kidney, where hyaline casts are found in the large tubules entrapping pus cells, found within them. In such cases much free pus is also to be seen.

A pus cell, as usually met with, is a spheroidal granular body about 1/2000 inch in diameter, containing as a rule no apparent nucleus. Ascetic acid, (a drop or two added to a few drops of pus on a slide) however, clarifies its substance, and causes the appearance of one or more circular bodies, like nuclei, about its centre. Strong alkali decomposes the cell, and finally causes its disappearance as a microscopic body.

Blood: A white blood corpuscle is not to be distinguished from a pus cell. The microscopic detection of blood therefore rests upon the red corpuscles. They are circular, yellowish bodies, of a very uniform size 1/8000 - 1/3000 inch in diameter, regular in outline, and homogeneous in appearance. They are never granular. The concavities of their sides are not always to be observed by focussing. Certain small flat crystals of uric acid of a shape between a square with bulging sides, and a distinctly spindle shape may be mistaken for them unless score or superior objectives be used. Where difficulty occurs, with a deposit presenting a large number of what appear to be blood corpuscles entire reliance should be placed upon the chemical test for blood.

Spermatozoa:- Semen may find entrance into urine, male and female, in a variety of ways. A diagnosis of spermatorrhœa is to be made only by repeated examinations, or a full knowledge of the history of the specimen, and of the individual at and for a time previous to its evacuation.

The diagnosis, and particularly the estimation of the severity or chronic nature of the loss, may be aided by the discovery of imperfect spermatozoa. Lallemand called attention years ago to the presence in the urine in cases of spermatorrhœa, of exceedingly round bright points, which he believed were tailless spermatozoids. Although unmentioned by others since, they may be sometimes found in connection with more perfect zoids, and even at times in cases of well recognized and long standing spermatorrhœa, without the latter. They thus become clinically important.